

## DIETARY L-CARNITINE IN SOWS DIETS INCREASES MILK YIELD AND GROWTH OF LITTERS

## DIJETALNI L-KARNITIN U OBROCIMA KRMAČA POVEĆAVA PRINOS MLIJEKA I RAST PRASADI

**K. Eder, A. Ramanau, H. Kluge, S. Jacobs**

Original scientific paper - Izvorni znanstveni članak

UDC: 636.4.:636.087.7.

Received - Primljeno: 12. may-svibanj 2004

### SUMMARY

This study confirms recent studies showing that the supplementation of sow diets with L-Carnitine increases reproductive performance. One important finding of this study was that L-Carnitine may increase the number of piglets born alive.

Another important finding was that sows supplemented with L-Carnitine were able to produce more milk than control sows. This might be the reason for the greater litter weight gains during lactation observed in this and previous studies.

Newborn or weaning pigs can synthesize L-Carnitine only to a low extent. Therefore, the increased concentration of L-Carnitine observed in the milk of sows supplemented with L-Carnitine could also induce a more efficient energy utilization in suckling piglets.

### INTRODUCTION

Recent studies have revealed that supplementing sows' diets with L-Carnitine during gestation and lactation increases the birth weights of their piglets. Moreover, the piglets of sows fed diets supplemented with L-Carnitine grew faster during the suckling period than the piglets of control sows. The reasons for these effects are largely unknown. The growth of piglets after birth is determined primarily by the supply of nutrients in the milk, which is their only source of food during the first few days of life. We therefore suspect that the faster growth of piglets from sows whose diets were supplemented with L-Carnitine during suckling might be due to increased milk production or higher nutrient levels in the milk. This study therefore investigated the effect of dietary

L-Carnitine supplementation on milk production and concentrations of various nutrients in the milk.

### MATERIALS AND METHODS

In this study, forty crossbred gilts (German Land Race x Large White) with an average body weight of 144 kg were assigned to two groups of 20 animals each. Their sexual cycle was synchronized by oral administration of 20 mg per day of altrenogest (*Regumate*<sup>®</sup>). The sows were artificially inseminated with sperm from Piétrain boars. In the

K. Eder, A. Ramanau, H. Kluge, Institute of Nutritional Sciences, University of Halle, Halle, Germany; S. Jacobs, Lohmann Animal Health, Cuxhaven, Germany.

first cycle, 16 of the 20 sows in each group conceived. After weaning, the trial continued for the second reproductive cycle. In this cycle 13 of the 16 sows in each group became pregnant. Sows that failed to conceive were removed from the experiment.

The sows were kept in single crates until d 30 of pregnancy. From d 30 to d 110 of gestation, the sows were kept in groups of eight in pens measuring 45 m<sup>2</sup> which had fully slatted floors, nipple drinkers and electronic feeding stations. On d 110 of pregnancy, they were moved to the farrowing accommodation, where they were housed in single farrowing pens. Two nutritionally balanced feed mixtures provided the basal ration (Table 1). The gestation diet provided 16 mg of L-Carnitine/kg, the lactation diet 4 mg of L-Carnitine/kg. From the beginning of the experiment until d 30 of pregnancy the sows were given 3.0 kg of gestation diet daily; from d 30 to d 110 the diet was available for *ad libitum* consumption. From d 110 to farrowing each sow was fed 2.5 kg of lactation diet. On the day of farrowing the sows were fed 1.5 kg/d, which was then successively increased (3 kg/d on d 1 and d 2 of lactation; 4.5 kg/d on d 3 and d 4 of lactation; *ad libitum* consumption from d 5 of lactation to weaning). From weaning until the second insemination the sows received 2.5 kg gestation diet daily. The sows in the treated group received a supplement of 125 mg of L-Carnitine (as *Carniking*<sup>®</sup>) per head and day during pregnancy and 250 mg L-Carnitine per head and day during lactation. The supplements were supplied as tablets. Water was provided by nipple drinking systems. On day 19 after farrowing, the

young piglets received a commercial piglet supplement for unrestricted feeding until weaning. There was no difference in the intake of this supplement between piglets of sows treated with L-Carnitine and piglets of control sows. In the first cycle, piglets were weaned on day 25 after farrowing, in the second cycle they were weaned on day 30 after farrowing. Data were generated over two consecutive reproductive cycles. Milk yield was determined on days 11 and 18 of lactation in 13 of the 16 sows in each treatment group in the first lactation, and in 10 of the 13 sows in each treatment group in the second lactation. In order to eliminate the effect of litter size on milk production, the litter size of these sows was standardized at 10 piglets/litter within two days after farrowing. Milk output was measured by the "weigh-suckle-weigh" method. To obtain milk for analysis, the sows were given 15 IU of oxytocin by intramuscular injection on d 11 of lactation, after termination of milk yield determination. A quantity of 80-100 ml milk was harvested manually from all active teats of each sow.

## RESULTS

### Feed intake, body weights of the sows and backfat

L-Carnitine supplementation did not influence feed intake from d 1 to d 110 of pregnancy, but increased feed intake during lactation (Table 2). L-Carnitine supplementation did not affect the sows' body weights or backfat thickness.

**Table 1. Nutrients in the experimental basal diets**  
**Tablica 1. Hranjiva tvari u pokusnim osnovnim obrocima**

Nutrient - Hranjiva tvar	Gestation diet - Obrok u bređosti	Lactation diet - Obrok u laktaciji
Energy - Energija (MJ ME/kg)	9.6	13.1
Crude protein - Sirova bjelančevina (g/kg)	150	178
Crude fat - Sirova masnoća (g/kg)	30	61
Crude fibre - Sirova vlaknina (g/kg)	114	48
Crude ash - Sirovi pepeo (g/kg)	62	58
Lysine - Lizin (g/kg)	7.0	9.5

**Table 2. Feed intake, body weights and backfat thickness of the sows in the first and the second reproductive cycle****Tablica 2. Unos hrane, tjelesne težine i debljina leđne masnoće krmača u prvom i drugom reproduktivnom ciklusu**

	1 <sup>st</sup> cycle - 1. ciklus		2 <sup>nd</sup> cycle - 2. ciklus		Significance of L-Carnitine Važnost L-karnitina
	Control Kontrola	+ L-Carnitine + L-karnitin	Control Kontrola	+ L-Carnitine + L-karnitin	(P)
No of litters - Broj legla	16	16	13	13	
Feed intake - Unos hranjivih tvari	kg/d				
Gestation - Bređost	3.2	3.2	3.3	3.5	NS <sup>1</sup>
Lactation - Laktacija	4.3	4.6	5.5	6.1	<0.01
Body weights - Tjelesne težine	kg				
d 1 of pregnancy - 1. dan bređosti	145	144	172	172	NS
d 85 of pregnancy - 85. dan bređosti	196	196	238	240	NS
d 110 of pregnancy - 110. dan bređosti	220	222	262	266	NS
At weaning - Kod odbića	171	166	207	210	NS
Backfat thickness .Debljina leđne masnoće	mm				
d 1 of pregnancy - 1. dan bređosti	16.4	16.6	16.8	15.8	NS
d 110 of pregnancy - 110. dan bređosti	19.3	18.9	23.9	23.5	NS
At weaning - Kod odbića	16.8	15.6	17.7	17.2	NS

<sup>1</sup> NS, not significant - NS, nije značajno (P>0.05)

### Number and birth weights of piglets

In both cycles, sows treated with L-Carnitine produced larger litters and more live-born piglets (+ 2.8 piglets/litter) than the control sows (Table 3). The

piglets of sows receiving dietary L-Carnitine showed lower birth weights (-10%) than those of the controls. However, the litter weights at birth of sows treated with L-Carnitine were significantly higher (+ 16%) than those of the control sows in both cycles.

**Table 3. Number and weights of piglets and litters at birth in the first and second reproductive cycle****Tablica 3. Broj i težine prašćića i legla kod rođenja u prvom i drugom reproduktivnom ciklusu**

	1 <sup>st</sup> cycle - 1. ciklus		2 <sup>nd</sup> cycle - 2. ciklus		Significance of L-Carnitine Važnost L-karnitina
	Control Kontrola	+ L-Carnitine + L-karnitin	Control Kontrola	+ L-Carnitine + L-karnitin	(P)
No of litters - Broj legla	16	16	13	13	
Piglets born - Prašćići rođeni (n)	10.2	12.9	10.8	13.5	<0.01
Piglets born alive - Živorodeni prašćići (n)	9.6	12.4	10.3	13.1	<0.01
Weights of piglets - Težine prašćića (kg)	1.54	1.39	1.70	1.53	<0.05
Weights of litters - Težine legla (kg)	14.2	16.8	17.3	19.6	<0.05

**Table 4. Weight gains of piglets during the suckling period in the first and second reproductive cycle**  
**Tablica 4. Prirasti težine prašćića u razdoblju sisanja u prvom i drugom reprodukcijom ciklusu**

	1 <sup>st</sup> cycle - 1. ciklus		2 <sup>nd</sup> cycle - 2. ciklus		Significance of L-Carnitine Važnost L-karnitina
	Control Kontrola	+ L-Carnitine + L-karnitin	Control Kontrola	+ L-Carnitine + L-karnitin	(P)
No of litters - Broj legla	13	13	10	10	
Birth weight - Težina kod rođenja (kg)	1.49	1.34	1.67	1.52	NS <sup>1</sup>
Weaning weight - Težina kod odbića (kg)	7.60	8.11	10.81	11.43	<0.05
Weight gain - Prirast težine (kg)	6.11	6.77	9.14	9.92	<0.01

<sup>1</sup> NS, not significant - NS, nije značajno (P>0.05)

**Table 5. Milk yield on day 11 and day 18 and amounts of nutrients secreted with milk on day 11 of lactation in the first and second cycle**

**Tablica 5. Prinos mlijeka 11. i 18. dana te količine hranjivih tvari izlučenih s mlijekom 11. dan laktacije u prvom i drugom ciklusu**

	1 <sup>st</sup> cycle - 1. ciklus		2 <sup>nd</sup> cycle - 2. ciklus		Significance of L-Carnitine Važnost L-karnitina
	Control Kontrola	+ L-Carnitine + L-karnitin	Control Kontrola	+ L-Carnitine + L-karnitin	(P)
No of litters - Broj legla	13	13	10	10	
Milk yield <sup>1</sup> - Prinos mlijeka <sup>1</sup>	kg/d				
d 11 - 11. dan	4.64	5.53	7.74	9.17	<0.05
d 18 - 18. dan	5.64	7.04	9.91	10.64	<0.05
Nutrients in the milk on day 11 Hranjive tvari u mlijeku 11. dana	g/kg milk				
Fat - Masnoća	81	83	89	82	NS <sup>2</sup>
Protein - Bjelančevina	44	43	50	48	NS
Lactose - Laktoza	51	53	55	54	NS
Gross energy - bruto energija (MJ/kg)	5.01	5.08	5.54	5.22	NS
L-Carnitine	74	109	62	75	<0.001
Nutrients secreted with milk on day 11 Hranjive tvari izlučene s mlijekom 11. dan	g/d				
Fat - Masnoća	375	458	689	758	NS
Protein - Bjelančevina	203	236	384	443	<0.05
Lactose - Laktoza	239	293	426	497	<0.05
	MJ/d				
Gross energy - bruto energija	23.3	28.1	42.8	48.0	<0.10

<sup>1</sup> Each sow nursed 10 piglets through the entire lactation - <sup>1</sup> Svaka je krmača othranila 10 prašćića u čitavoj laktaciji.

<sup>2</sup> NS, not significant - NS, nije značajno (P>0.05)

## PIGLETS' WEIGHT GAINS DURING SUCKLING

The piglets' average weights after litter sizes had been standardized to 10 piglets/litter were similar to those before standardization. In both cycles the piglets of sows treated with L-Carnitine showed greater weight gains (+ 10%) over the entire suckling period than the control sows' piglets. The piglets from sows treated with L-Carnitine were therefore 6% heavier at weaning than those of the control sows.

## MILK YIELD, MILK CONSTITUENTS AND AMOUNTS OF NUTRIENTS SECRETED

Sows supplemented with L-Carnitine produced more milk on d 11 (+ 19%) and d 18 (+ 14%) of lactation than control sows (Table 5). This effect was evident in both lactations. The concentrations of fat, protein and lactose and the amount of gross energy in the milk did not differ between sows supplemented with L-Carnitine and control sows. In both lactations sows supplemented with L-Carnitine secreted more protein (+ 16%) and lactose (+ 19%) daily in their milk than control sows. There was also a tendency towards a higher level of gross energy secretion (+ 15%) in the milk of sows supplemented with L-Carnitine ( $P < 0.10$ ). The milk of sows treated with L-Carnitine also contained higher concentrations of L-Carnitine than the milk of the control sows.

## L-CARNITINE SUPPLEMENTATION

The large body of research results suggests that permanent L-Carnitine supplementation gives the best response in reproducing sows. The recommended level is 50 mg of L-Carnitine per kg of feed. Gilts should start to receive supplements when they are introduced into the sow herd.

## REFERENCES

1. Daza, A., M. Cirera, E. Ansón, E. Boix, J. F. Gálvez (1999.) Efecto de la L-Carnitina sobre los resultados reproductivos de cerdas y sobre el crecimiento de los lechones durante la lactación. *Anaporc* 195 (Dec): 62-70.
2. Eder, K., A. Ramanau, H. Kluge (2001.): Effect of L-Carnitine supplementation on performance parameters in gilts and sows. *J. Anim. Physiol. and Anim. Nutr.* 85, 73-80.
3. Eder, K., A. Ramanau, H. Kluge (2003.): Benefits of long term L-Carnitine in sows. *Int. Pig Topics* 18(2): 25-26.
4. Fremaut, D. J., G. De Raeymaecker, J. Latré, J. V. Aerts (1993.): Hebben lakterende zeugen een tekort aan L Carnitine? *Varkensbedrijf* 3(6): 20-3.
5. Jacobs, S. (2002.): Practical experiences with L-Carnitine. *Lohmann Information* 26, 21-24.
6. Musser, R. E., R. D. Goodband, M. D. Tokach, K. Q. Owen, J. L. Nelssen, S. A. Blum, S. S. Dritz, C. A. Civis (1999.): Effects of L-Carnitine fed during gestation and lactation on sow and litter performance. *J. Anim. Sci.* 77, 3289-3295.
7. Musser, R. E., R. D. Goodband, M. D. Tokach, K. Q. Owen, J. L. Nelssen, S. A. Blum, R. G. Campbell, R. Smits, S. S. Dritz, C. A. Civis (1999.): Effects of L-Carnitine fed during lactation on sow and litter performance. *J. Anim. Sci.* 77: 3296-3303.
8. Musser, R. E. (1999.): Additional L-Carnitine in the gestating sow diet improves carcass characteristics of the offspring. *Swine Day (Kansas State University):* 37-40.
9. Musser, R. E. (1999.): L-Carnitine influences the number of pigs born alive per litter. *Swine Update (Kansas State University Agricultural Experiment. Station and Co-operative Extension Service, Manhattan, Kansas)* 21(1): 1-3.
10. Owen, K. Q., J. L. Nelssen, R. D. Goodband, M. D. Tokach, K. G. Friesen (2001.): Effect of dietary L-Carnitine on growth performance and body composition in nursery and growing-finishing pigs. *J. Anim. Sci.* 79: 1509-1515.
11. Owen, K. Q., J. L. Nelssen, R. D. Goodband, T. L. Weeden, S. A. Blum (1996.): Effect of L-Carnitine and soybean oil on growth performance and body composition of early-weaned pigs. *J. Anim. Sci.* 74: 1612-1619.
12. Ramanau, A., H. Kluge, J. Spilke, K. Eder (2002.): Reproductive performance of sows supplemented with dietary L-Carnitine over three reproductive cycles. *Arch. Anim. Nutr.* 56, 287-296.
13. Weber, M., P. Stenzel, S. Jacobs (2000.): Untersuchung zur Wirksamkeit von L-Carnitin auf die Leistung von Sauen. 6th Conference "Schweine- und Geflügelernährung", Lutherstadt-Wittenberg, 21-23 Nov. 2000, 2 pp.
14. Zollitsch, W., S. Wlcek, F. Reisenberger (2002.): Ist ein Carnitin-Zusatz zum Zuchtsauenfutter sinnvoll? Antworten aus einem Praxisversuch. *VÖS-Magazin (Fach- und Mitteilungsblatt des Verbandes österreichischer Schweineerzeuger)* No 12.

## SAŽETAK

Ovaj rad potvrđuje novija istraživanja što pokazuju da dodavanje L-karnitina u obroke krmača povećava reprodukciju performansi. Jedno važno otkriće ovog rada je da L-karnitin može povećati broj živorođenih praščića.

Drugo važno otkriće je da su krmače koje su dobivale L-karnitin mogle proizvesti više mlijeka nego kontrolne krmače. To bi mogao biti razlog za veće povećanje težine prasadi u laktaciji, primijećeno u ovom i ranijim istraživanjima.

Novorođeni praščići ili kod odbića mogu samo u manjoj mjeri sintetizirati L-karnitin. Stoga, povećana koncentracija L-karnitina zapažena u mlijeku krmača koje su dobivale L-karnitin mogla je također potaći djelotvornije iskorištavanje energije u sisajućih praščića.

suradnjom s našom tvrtkom  
uvjerit ćete se u našu  
**POUZDANOST**  
kojoj je temelj naša  
**STRUČNOST**  
kao i desetogodišnje  
**ISKUSTVO**  
uz primjenu najmodernijih  
**TEHNOLOGIJA**  
u proizvodnji

**PROIZVODI GARANTIRANE KVALITETE**  
**KRMNE SMJESE - PREMIKSI - KUŠKOVITI - PROTEINSKI DODACI**

**KUŠIĆ PROMET d.o.o.** za proizvodnju, trgovinu i usluge  
Psarjevo donje 61 - 10380 Sv. Ivan Zelina  
tel./fax: 01/2069-202, 2043-403, 2043-404  
e-mail: info@kusic-promet.hr

[www.kusic-promet.hr](http://www.kusic-promet.hr)

HRVATSKA HRANA  
ZDRAVA HRANA

CERTIFIED QUALITY SYSTEM  
UNEN ISO 9001/2000  
SINCERT DNV